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ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample and a personnel evaluation form are also included. (AG)

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United States Employment Service Technical Report

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Development of USES Aptitude Test Battery for

Programmer, Business

(profess. & kin.) 020.188

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U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION

Technical Report on Development of USES Aptitude Test Battery

For

Programmer, Business (profess. & kin.) 020.188

S-314

(Developed in Cooperation with the California,
Ohio and Wisconsin State Employment Services)

U.S. DEPARTMENT OF LABOR
Willard Wirtz, Secretary

MANPOWER ADMINISTRATION
Stanley H. Ruttenberg
Administrator

BUREAU OF EMPLOYMENT SECURITY
Robert C. Goodwin, Administrator

U.S. EMPLOYMENT SERVICE
Charles E. Odell,
Director

March 1968

FOREWORD

The United States Employment Service General Aptitude Test Battery (GATB) was first published in 1947. Since that time the GATB has been included in a continuing program of research to validate the tests against success in many different occupations. Because of its extensive research base the GATB has come to be recognized as the best validated multiple aptitude test battery in existence for use in vocational guidance.

The GATB consists of 12 tests which measure 9 aptitudes: General Learning Ability, Verbal Aptitude, Numerical Aptitude, Spatial Aptitude, Form Perception, Clerical Perception, Motor Coordination, Finger Dexterity, and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, with a standard deviation of 20.

Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, in combination, predict job performance. For any given occupation, cutting scores are set only for those aptitudes which contribute to the prediction of performance of the job duties of the experimental sample. It is important to recognize that another job might have the same job title but the job content might not be similar. The GATB norms described in this report are appropriate for use only for jobs with content similar to that shown in the job description included in this report.

Charles E. Odell, Director
U. S. Employment Service

DEVELOPMENT OF USES APTITUDE TEST BATTERY

FOR

Programmer, Business (profess. & kin.) 020.188-026

S-314

This report describes research undertaken for the purpose of validating and cross-validating General Aptitude Test Battery (GATB) norms for the occupation of Programmer, Business (profess. & kin.) 020.188-026. The following norms were established:

GATB Aptitudes	Minimum Acceptable GATB Scores
G - General Learning Ability	115
V - Verbal Aptitude	105
N - Numerical Aptitude	110
S - Spatial Aptitude	105

RESEARCH SUMMARY - VALIDATION SAMPLE

Sample:

102 (82 male and 20 female) workers employed as Business Programmers at various establishments in Milwaukee, Wisconsin affiliated with the Data Processing Management Association.

Criterion:

Supervisory ratings

Design:

Concurrent (test and criterion data were collected at approximately the same time.)

Minimum aptitude requirements were determined on the basis of a job analysis and statistical analyses of aptitude mean scores, standard deviations, and selective efficiencies.

Concurrent Validity:

Phi Coefficient = .33 (P/2 less than .0065)

Effectiveness of Norms:

Only 69% of the nontest-selected workers used for this study were good workers; if the workers had been test-selected with the S-314 norms, 79% would have been good workers. 31% of the nontest-selected workers used for this study were poor workers; if the workers had been test-selected with the S-314 norms, only 21% would have been poor workers. The effectiveness of the norms is shown graphically in Table 1:

TABLE 1

Effectiveness of Norms

	Without Tests	With Tests
Good Workers	69%	79%
Poor Workers	31%	21%

VALIDATION SAMPLE DESCRIPTION

Size:

N = 102

Occupational Status:

Employed workers

Work Setting:

Allis-Chalmers Manufacturing Company
Badger Mutual Insurance Company
First Wisconsin National Bank
Heil Company
Marine National Exchange Bank
Marshall and Ilsley Bank
George J. Meyer Manufacturing Company
Miller Brewing Company
Milwaukee Gas Light Company
Mobil Oil Company
Northwestern Mutual Life Insurance Company
Joseph Schlitz Brewing Company
A. O. Smith Corporation
West Bend Aluminum Company
Wisconsin Electric Power Company
Wisconsin Telephone Company

Employer Selection Requirements:

Education: High School graduation

Previous Experience: Completion of one month IBM programmer training course.

Tests: IBM Revised Programmer Aptitude Test

Principal Activities:

The job duties for each worker are comparable to those shown in the job description on the Fact Sheet in the Appendix.

Minimum Experience:

All workers in the sample had at least one month total job experience.

TABLE 2

Means, Standard Deviations, Ranges and Pearson Product-Moment Correlations with the Criterion (r) for Age, Education, and Experience

	Mean	SD	Range	r
Age (years)	29.7	6.7	18-51	-.104
Education (years)	14.4	1.8	12-18	.176
Experience (months)	25.5	21.3	1-90	.007

EXPERIMENTAL TEST BATTERY

All 12 tests of the GATB, B-1002B were administered during the period of April 1962 to April 1963.

CRITERION

The criterion data consisted of supervisory ratings of job proficiency made at approximately the same time as test data were collected. The worker's immediate supervisor made two ratings with a time interval of at least three weeks between ratings.

Rating Scale:

USES Form SP-21 "Descriptive Rating Scale." (See Appendix.) This scale consists of nine items covering different aspects of job performance. Each item has five alternatives corresponding to different degrees of job proficiency.

Reliability:

The coefficient of reliability between the two ratings is .96 indicating a significant relationship. Therefore, the final criterion consisted of the combined scores of the two sets of ratings.

Criterion Score Distribution:

Possible Range:	18-90
Actual Range:	38-90
Mean:	70.0
Standard Deviation:	11.0

Criterion Dichotomy:

The criterion distribution was dichotomized into low and high groups by placing 31% of the sample in the low group to correspond with the percentage of workers considered unsatisfactory or marginal. Workers in the high criterion group were designated as "good workers" and those in the low group as "poor workers." The criterion critical score is 66.

APTITUDES CONSIDERED FOR INCLUSION IN THE NORMS

Aptitudes were selected for tryout in the norms on the basis of a qualitative analysis of job duties involved and a statistical analysis of test and criterion data. Aptitudes V and Q which do not have a high correlation with the criterion were considered for inclusion in the norms because the qualitative analysis indicated that these aptitudes were important for the job duties and the sample had a relatively high mean score on aptitude Q and a relatively low standard deviation on aptitude V. With employed workers a relatively high mean score may indicate that some sample pre-selection has taken place. Tables 3, 4 and 5 show the results of the qualitative and statistical analyses.

TABLE 3

Qualitative Analysis

(Based on the job analysis the aptitudes indicated appear to be important to the work performed)

<u>Aptitude</u>	<u>Rationale</u>
G - General Learning Ability	Required to understand and apply work statement instructions, recommended procedural routines, and related informational data; to identify and organize elements of a problem into logical sequence for computer operation by means of preparing block diagrams and flow charts. Required to make analytical and logical analyses in planning procedural routines; to have a working knowledge of the company business organization and management and with modern office methods and procedures; and to have a complete familiarity with programming principles and techniques in order to discuss programming methods, requirements, and approaches with line and staff personnel.
V - Verbal Aptitude	Required to read and understand work statements, procedural routines, and related data; to give and exchange information pertinent to programming techniques and principles while attending briefings, meetings, and interviews; and to document programs and prepare accurate and complete reports.
N - Numerical Aptitude	Required to make an analytical and logical analysis of mathematical problems, resolve computations, and arrange computations into proper program sequence for computer operations.
S - Spatial Aptitude	Required to mentally visualize flow of data through computer system. Required to interpret and develop diagrams and flow charts in proper relationships to obtain desired final printed results.

Q - Clerical Perception

Required to perceive pertinent detail in program documentation, assembled data, and recommended program routines; to prepare input, output, and nomenclature lists; and to translate step by step instructions from flow chart for the console operator. Required to recognize and detect errors in program instructions, to correct errors by altering sequence of flow chart steps, and to avoid perceptual errors in making computations.

TABLE 4

Means, Standard Deviations (SD), Ranges and Pearson Product-Moment Correlations with the Criterion (r) for the Aptitudes of the GATB; N=102

Aptitudes	Mean	SD	Range	r
G - General Learning Ability	132.1	12.4	102-159	.359**
V - Verbal Aptitude	124.8	13.2	94-160	.046
N - Numerical Aptitude	130.8	13.7	95-157	.396**
S - Spatial Aptitude	121.6	16.1	81-166	.238*
P - Form Perception	120.4	15.6	84-157	.128
Q - Clerical Perception	127.7	15.7	88-167	.175
K - Motor Coordination	117.4	14.0	86-151	.175
F - Finger Dexterity	109.3	19.1	66-164	.013
M - Manual Dexterity	112.6	20.6	56-158	.281**

*Significant at the .05 level

**Significant at the .01 level

TABLE 5

Summary of Qualitative and Quantitative Data

Type of Evidence	Aptitudes									
	G	V	N	S	P	Q	K	F	M	
Job Analysis Data										
<u>Important</u>	X	X	X	X		X				
Irrelevant										
Relatively High Mean	X		X			X				
Relatively Low Standard Dev.	X	X	X				X			
Significant Correlation with Criterion	X		X	X					X	
Aptitudes to be Considered for Trial Norms	G	V	N	S		Q			M	

DERIVATION AND VALIDITY OF NORMS

Final norms were derived on the basis of a comparison of the degree to which trial norms consisting of various combinations of aptitudes G, V, N, S, Q and M at trial cutting scores were able to differentiate between the 69% of the sample considered good workers and the 31% of the sample considered poor workers. Trial cutting scores at five-point intervals approximately one standard deviation below the mean are tried because this will eliminate about one-third of the sample with three-aptitude norms. For two-aptitude trial norms, minimum cutting scores slightly more than one standard deviation below the mean will eliminate about one-third of the sample; for four-aptitude trial norms, cutting scores slightly less than one standard deviation below the mean will eliminate about one-third of the sample. The Phi Coefficient was used as a basis for comparing trial norms. The optimum differentiation for the occupation of Programmer, Business 020, 198-026 was provided by the norms of G-115, V-105, N-110 and S-105. The validity of these norms is shown in Table 6 and is indicated by a Phi Coefficient of .33 (statistically significant at the .0005 level).

TABLE 6

Concurrent Validity of Test Norms G-115, V-105, N-110, S-105

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Good Workers	13	57	70
Poor Workers	17	15	32
Total	30	72	102

Phi Coefficient = .33
Significance Level = P/2 less than .0005

Chi Square (χ^2_y) = 11.0

DETERMINATION OF OCCUPATIONAL APTITUDE PATTERN

The data for this study met the requirements for incorporating the occupation studied into OAP-1 which is shown in Section II of the Manual for the General Aptitude Test Battery. A Phi Coefficient of .26 is obtained with the OAP-1 norms G-125, N-115 and S-115.

CHECK STUDY RESEARCH SUMMARY SHEET

S-314

GATB #2447

Programmer, Business (profess. & kin.) 020.188-026

Check Study #1 Research Summary

Sample.

93 (77 male and 16 female) workers employed as Business Programmers in California.

TABLE 7

Means, Standard Deviations (SD), Ranges, and Pearson Product-Moment Correlations with the Criterion (r) for Age, Education, Experience and the Aptitudes of the GATB-Cross-Validation Sample #1

Age (years)	34.5	7.8	22-53	-.203
Education (years)	14.2	2.1	10-20	.139
Experience (months)	30.9	19.6	6-108	-.051
G - General Learning Ability	128.7	16.1	91-157	.371**
V - Verbal Aptitude	124.5	15.6	90-170	.313**
N - Numerical Aptitude	124.6	15.6	91-161	.347**
S - Spatial Aptitude	121.6	15.0	84-156	.247*
P - Form Perception	117.8	15.7	83-163	.222*
Q - Clerical Perception	126.1	18.3	87-194	.299**
K - Motor Coordination	119.3	16.5	74-151	.029
F - Finger Dexterity	106.7	17.7	57-158	-.009
M - Manual Dexterity	112.7	20.8	57-154	-.019

*Significant at the .05 level

**Significant at the .01 level

Design :

Concurrent (test and criterion data were collected at approximately the same time.)

Principal Activities :

The job duties for each worker are comparable to those shown in the job description in the Appendix.

Concurrent Validity :

Phi Coefficient = .29 ($P/2 < .005$)

Effectiveness of Norms

Only 67% of the nontest-selected workers used for this study were good workers; if the workers had been test-selected with the S-314 norms, 77% would have been good workers. 33% of the nontest-selected workers used for this study were poor workers; if the workers had been test-selected with the S-314 norms, only 23% would have been poor workers. The effectiveness of the norms is shown graphically in Table 8:

TABLE 8

Effectiveness of S-314 Norms on Check Study Sample #1

	Without Tests	With Tests
Good Workers	67%	77%
Poor Workers	33%	23%

TABLE 9

Concurrent Validity of S-314 Norms on Check Study Sample #1

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Good Workers	13	49	62
Poor Workers	16	15	31
Total	29	64	93

Phi Coefficient (ϕ) = .29
Significance Level = $P/2 < .005$

Chi Square (χ^2_y) = 7.7

Programmer, Business (profess. & kin.) 020.188-026

Check Study #2 Research Summary

Sample:

62 workers (56 male & 6 female) employed as Business Programmers by various firms and governmental agencies in Ohio.

TABLE 10

Means, Standard Deviations (SD), Ranges and Pearson-Product Moment Correlations with the Criterion (r) for Age, Education, Experience and the Aptitudes of the GATB-Cross-Validation Sample #2

	Mean	SD	Range	r
Age (years)	32.3	5.6	25- 52	-.192
Education (years)	15.9	.8	14- 18	.174
Experience (months)	50.9	20.9	24-132	-.028
G - General Learning Ability	128.0	13.4	93-154	.276*
V - Verbal Aptitude	120.9	14.1	92-151	.128
N - Numerical Aptitude	123.5	16.3	74-153	.246
S - Spatial Aptitude	122.7	15.7	91-166	.337**
P - Form Perception	113.7	17.5	76-156	.118
Q - Clerical Perception	119.7	15.9	81-152	.221
K - Motor Coordination	111.1	16.4	78-153	.017
F - Finger Dexterity	99.7	18.0	55-135	.322*
M - Manual Dexterity	99.5	24.1	51-159	.181

*Significant at the .05 level

**Significant at the .01 level

Criterion:

Supervisory ratings

Design:

Concurrent (test and criterion data were collected at approximately the same time).

Principal Activities:

The duties for this sample are comparable to those shown in the job description in the Appendix.

Concurrent Validity:

Phi Coefficient (ϕ) = .23 ($P/2 < .05$)

Effectiveness of Norms:

Only 65% of the nontest-selected workers used for this study were good workers; if the workers had been test-selected with the S-314 norms, 74%

would have been good workers. 35% of the nontest-selected workers used for this study were poor workers; if the workers had been test-selected with S-314 norms only 26% would have been poor workers. The effectiveness of the norms is shown graphically in Table 11.

TABLE 11
Effectiveness of S-314 Norms on
Check Study Sample #2

Good Workers	65%	74%
Poor Workers	35%	26%

TABLE 12
Concurrent Validity of S-314 Norms
(G-115, V-105, N-110, S-105)
Check Study #2

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Good Workers	11	29	40
Poor Workers	12	10	22
Total	23	39	62

Phi Coefficient = .23
Significance Level = $P/2 < .05$

Chi Square (χ^2_y) = 3.4

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SP-21
Rev. 2/61

A-P-P-E-N-D-I-X

DESCRIPTIVE RATING SCALE
(For Aptitude Test Development Studies)

Score _____

RATING SCALE FOR _____
D. O. T. Title and Code

Directions: Please read Form SP-20, "Suggestions to Raters", and then fill in the items listed below. In making your ratings, only one box should be checked for each question.

Name of Worker (print) _____
(Last) (First)

Sex: Male _____ Female _____

Company Job Title: _____

How often do you see this worker in a work situation?

- ☐ See him at work all the time.
☐ See him at work several times a day.
☐ See him at work several times a week.
☐ Seldom see him in work situation.

How long have you worked with him?

- ☐ Under one month.
☐ One to two months.
☐ Three to five months.
☐ Six months or more.

A. How much work can he get done? (Worker's ability to make efficient use of his time and to work at high speed.)

- ☐ 1. Capable of very low work output. Can perform only at an unsatisfactory pace.
- ☐ 2. Capable of low work output. Can perform at a slow pace.
- ☐ 3. Capable of fair work output. Can perform at an acceptable but not a fast pace.
- ☐ 4. Capable of high work output. Can perform at a fast pace.
- ☐ 5. Capable of very high work output. Can perform at an unusually fast pace.

B. How good is the quality of his work? (Worker's ability to do high-grade work which meets quality standards.)

- ☐ 1. Performance is inferior and almost never meets minimum quality standards.
- ☐ 2. The grade of his work could stand improvement. Performance is usually acceptable but somewhat inferior in quality.
- ☐ 3. Performance is acceptable but usually not superior in quality.
- ☐ 4. Performance is usually superior in quality.
- ☐ 5. Performance is almost always of the highest quality.

C. How accurate is he in his work? (Worker's ability to avoid making mistakes.)

- ☐ 1. Makes very many mistakes. Work needs constant checking.
- ☐ 2. Makes frequent mistakes. Work needs more checking than is desirable.
- ☐ 3. Makes mistakes occasionally. Work needs only normal checking.
- ☐ 4. Makes few mistakes. Work seldom needs checking.
- ☐ 5. Rarely makes a mistake. Work almost never needs checking.

D. How much does he know about his job? (Worker's understanding of the principles, equipment, materials and methods that have to do directly or indirectly with his work.)

- ☐ 1. Has very limited knowledge. Does not know enough to do his job adequately.
- ☐ 2. Has little knowledge. Knows enough to "get by."
- ☐ 3. Has moderate amount of knowledge. Knows enough to do fair work.
- ☐ 4. Has broad knowledge. Knows enough to do good work.
- ☐ 5. Has complete knowledge. Knows his job thoroughly.

E. How much aptitude or facility does he have for this kind of work? (Worker's adeptness or knack for performing his job easily and well.)

- ☐ 1. Has great difficulty doing his job. Not at all suited to this kind of work.
- ☐ 2. Usually has some difficulty doing his job. Not too well suited to this kind of work.
- ☐ 3. Does his job without too much difficulty. Fairly well suited to this kind of work.
- ☐ 4. Usually does his job without difficulty. Well suited to this kind of work.
- ☐ 5. Does his job with great ease. Exceptionally well suited for this kind of work.

F. How large a variety of job duties can he perform efficiently? (Worker's ability to handle several different operations in his work.)

- ☐ 1. Cannot perform different operations adequately.
- ☐ 2. Can perform a limited number of different operations efficiently.
- ☐ 3. Can perform several different operations with reasonable efficiency.
- ☐ 4. Can perform many different operations efficiently.
- ☐ 5. Can perform an unusually large variety of different operations efficiently.

G. How resourceful is he when something different comes up or something out of the ordinary occurs? (Worker's ability to apply what he already knows to a new situation.)

- ☐ 1. Almost never is able to figure out what to do. Needs help on even minor problems.
- ☐ 2. Often has difficulty handling new situations. Needs help on all but simple problems.
- ☐ 3. Sometimes knows what to do, sometimes doesn't. Can deal with problems that are not too complex.
- ☐ 4. Usually able to handle new situations. Needs help on only complex problems.
- ☐ 5. Practically always figures out what to do himself. Rarely needs help, even on complex problems.

H. How many practical suggestions does he make for doing things in better ways? (Worker's ability to improve work methods.)

- ☐ 1. Sticks strictly with the routine. Contributes nothing in the way of practical suggestions.
- ☐ 2. Slow to see new ways to improve methods. Contributes few practical suggestions.
- ☐ 3. Neither quick nor slow to see new ways to improve methods. Contributes some practical suggestions.
- ☐ 4. Quick to see new ways to improve methods. Contributes more than his share of practical suggestions.
- ☐ 5. Extremely alert to see new ways to improve methods. Contributes an unusually large number of practical suggestions.

I. Considering all the factors already rated, and only these factors, how acceptable is his work? (Worker's "all-around" ability to do his job.)

- ☐ 1. Would be better off without him. Performance usually not acceptable.
- ☐ 2. Of limited value to the organization. Performance somewhat inferior.
- ☐ 3. A fairly proficient worker. Performance generally acceptable.
- ☐ 4. A valuable worker. Performance usually superior.
- ☐ 5. An unusually competent worker. Performance almost always top notch.

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FACT SHEET

Job Title: Programmer, Business (profess. & kin.) 020.188-026

Job Summary: Develops and prepares diagrammatic plans and written instructions for solution of business problems by means of automatic data-processing equipment.

Work Performed: Converts symbolic statement of business problems to detailed logical flow charts for coding into computer language. Analyzes all or part of work flow chart or diagram representing business problem by applying knowledge of computer capabilities, subject matter, algebra and symbolic logic to develop sequence of program steps. Confers with supervisor and representatives of departments affected by program, to resolve questions of program intent, output requirements, input data acquisition, extent of automatic programming and coding use and modification, and inclusion of internal checks and controls. Writes detailed logical flow chart in symbolic form to represent work order of data to be processed by the computer system, and describe input, output, arithmetic and logical operations involved. Converts detail logical flow chart to language processable by computer. Devises sample input data to provide test of program adequacy. Prepares block diagrams to specify equipment configuration. Observes or runs tests of coded program on computer using actual or sample input data. Corrects program errors by such methods as altering program steps and sequence. Prepares written instruction (run book) to guide operating personnel during production runs. Analyzes, reviews, and rewrites programs to increase operating efficiency or adapt to new requirements. Compiles documentation of program development and subsequent revisions. May specialize in writing programs for one make and type of computer.

Effectiveness of Norms: Only 69% of the nontest-selected workers used for this study were good workers; if the workers had been test-selected with the S-314 norms, 79% would have been good workers. 31% of the nontest-selected workers used for this study were poor workers; if the workers had been test-selected with the S-314 norms, only 21% would have been poor workers.

Applicability of S-314 Norms: The aptitude test battery is applicable to jobs which include a majority of duties described above.